



Lawrence Livermore National Laboratory

Weapons and Complex Integration

The Weapons and Complex Integration Principal Directorate is responsible for ensuring the safety, reliability and security of the U.S. nuclear weapon stockpile without nuclear testing, for developing advanced manufacturing and materials technologies to maintain the stockpile, and for ensuring the safe dismantlement of retired weapons.

Stewardship of the U.S. nuclear weapons stockpile is a core responsibility of the Lawrence Livermore National Laboratory (LLNL). Partnering with other members of the nation's nuclear weapons complex, the programs executed by LLNL's Weapons and Complex Integration Principal Directorate underpin the success of the national Stockpile Stewardship Program.

With the end of the Cold War, the United States declared a moratorium on nuclear testing and the development of new nuclear weapon designs. A science-based Stockpile Stewardship Program was defined to sustain the country's nuclear deterrent for the indefinite future.

With no new nuclear weapons entering the U.S. stockpile, the warheads currently in the stockpile must continue to function far past their original expected lifetimes. Confidence in the performance of these weapons is maintained through an ongoing process of stockpile surveillance, assessment and certification and warhead refurbishment through a life-extension program (LEP). LLNL is the lead nuclear design laboratory for the LEP on the Los Alamos-designed W78 warhead. The W78 is the fourth nuclear weapon system in the stockpile to undergo refurbishment. In 2004, LLNL successfully completed the first LEP of a warhead, the Livermore-designed W87.

A host of dramatically improved scientific and technical capabilities have been developed since the program's inception

to enable—without the need for nuclear testing—the assessment and certification of the safety, security and reliability of existing warheads as well as the renewed weapons that are the product of life extension programs.

Breakthrough science and engineering underpin LLNL's contributions to the Stockpile Stewardship Program. Using state-of-the-art experimental facilities and world-leading computer resources, Laboratory scientists and engineers conduct robust nonnuclear experiments and enhanced computational simulations that are then benchmarked and validated against past nuclear test data.

Simulation and Computation

The Advanced System Simulation and Computation Program provides the integrating simulation and modeling capabilities and technologies needed to combine new and old experimental data, past nuclear test data and past design and engineering experience into a powerful tool for the certification of existing nuclear weapons and components, as well as stockpile life extension programs. The program makes extensive use of LLNL's array of supercomputers, including the 20-petaflop/s Sequoia machine, one of the world's most powerful computing systems.

Simulations run on the 44-teraflop/s Atlas supercomputer are shedding light on plutonium's unique characteristics, including its almost complete absence of magnetism.

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An explosive pulsed-power capability is being developed for measuring properties of weapon materials under extreme conditions.

Primary Design

The Primary Nuclear Design Program brings extensive experimental and theoretical expertise to a broad range of applications, including the design of nuclear weapon primaries, shock hydrodynamics, nuclear physics, high-explosive research and development, the science of materials under extreme conditions, nuclear emergency response and advanced conventional weapons design. The program draws on a wide circle of resources, making extensive use of the High Explosives Application Facility and Contained Firing Facility at Livermore, the Dual-Axis Radiographic Hydrotest Facility at Los Alamos National Laboratory and the U1a Complex at the Nevada National Security Site.

Secondary Design

The Secondary Nuclear Design Program maintains scientific and technical expertise in all aspects of thermonuclear weapon physics, design and operation through the application of theoretical, computational and experimental physics to a wide range of "grand challenge" problems relevant to national defense and security. The program pursues research in astrophysics, atomic and nuclear physics, computational physics, fluid dynamics and turbulence, high-energy-density physics and radiation transfer and particle transport. The National Ignition Facility, which houses the world's most energetic laser system, provides a unique experimental venue for the program.

Weapon Engineering

The Nuclear Weapon Engineering Program supports activities in stockpile weapon monitoring and life extension. The program conducts component fabrication development projects to ensure the reliability, safety and security of the enduring stockpile and

conducts warhead design studies to maintain the capability to implement a weapon development process. It also develops sophisticated engineering software, such as the DYNA and ParaDyn dynamic structural response codes, and performs leading-edge modeling and analysis of complex engineering problems in solid mechanics and heat transfer.

Nuclear Materials

The Nuclear Materials Technology Program manages all special nuclear material operations at the Laboratory, including those involving highly enriched uranium, plutonium and tritium. The program also conducts research to understand what happens to plutonium's physical and chemical properties over time, performs surveillance of stockpile pits and manufactures parts for subcritical tests that help ensure the safety and reliability of the nuclear stockpile. This work is conducted at LLNL's Superblock facility, one of only two defense plutonium research and development facilities in the United States.

LLNL Stockpile Stewardship Achievements

Laboratory scientists and engineers have made critical contributions to the success of the Stockpile Stewardship Program. For example, they determined that the plutonium pits for most nuclear weapons have lifetimes of 85 to 100 years (double previous estimates). They also developed the first three-dimensional quantitative model of energy balance within an exploding nuclear weapon. These and other LLNL accomplishments are essential steps on the path to a predictive stockpile assessment capability.

For more information, contact the LLNL Public Affairs Office, P.O. Box 808, Mail Stop L-3, Livermore, California 94551 (925-422-4599) or visit our website at www.llnl.gov.

LLNL is managed by Lawrence Livermore National Security, LLC, for the U.S. Department of Energy, National Nuclear Security Administration, under Contract DE-AC52-07NA27344.

LLNL-BR-423443



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